

U.S. Patent Application No. 09/654,182
Amendment dated September 15, 2006
Reply to Office Action of June 15, 2006

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REMARKS

Reconsideration and continued examination of the above-identified application are respectfully requested.

Claims 1-10 and 16-49 are pending. In the Office Action dated June 15, 2006, claims 1-10 and 16-49 are rejected. No claim is allowed.

In the present response, claims 1, 5, and 6 have been amended to recite that the carbonaceous material is particles having a size of from about 1 micron to about 500 microns. Full support for this amendment can be found throughout the present application, including page 8, lines 10-25, of the present application. Accordingly, no questions of new matter should arise and entry of this Amendment is respectfully requested.

Rejection of claims 1-7 and 9 under 35 U.S.C. §102(b) over Stalling et al.

At page 2 of the Office Action, the Examiner rejects claims 1-7 and 9 under 35 U.S.C. §102(b) over Stalling et al. (U.S. Patent No. 5,308,481). The Examiner alleges that Stalling et al. discloses the claimed separation device, such as the claimed chromatography device, wherein the stationary phase comprises carbonaceous material, such as fullerenes, having attached at least one organic group such as an aromatic-(C_nH_{n+1}) group, where n is in the claimed range. The Examiner further alleges that Stalling et al. discloses glycol as an organic chemical attached to the carbonaceous material and further discloses that the carbonaceous material can have more than one organic molecule attached. For the following reasons, this rejection is respectfully traversed.

Independent claims 1 and 5 are directed to a chromatography column and a separation

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device, respectively, comprising a mobile phase and a stationary phase, wherein the stationary phase comprises carbonaceous material having attached at least one organic group. Independent claim 6 is directed to a method for conducting separation of chemical species from a substance, wherein the method comprises passing the substance through a system containing a mobile phase and a stationary phase, wherein the stationary phase comprises carbonaceous material having attached at least one organic group. As shown in amended claims 1, 5, and 6, the carbonaceous material is particles having a size of from about 1 micron to about 500 microns. The carbonaceous material is the stationary phase and organic groups are attached to the carbonaceous material. As described for example at page 9, line 18 to page 10, line 4 and elsewhere in the present specification, the attached organic group affects the adsorbent capacity and selectivity of the carbonaceous material.

Unlike the claimed invention, Stalling et al. actually shows conventional resin and silica supports being used as the stationary phases, wherein very small diameter fullerenes are attached onto the resin and silica supports using reactive groups. It is noted that these fullerenes are extremely small in size. As shown in Figure 1A of Stalling et al., the size of the resin or silica support is shown as 1.9 microns, and the attachment of the fullerene would be significantly smaller than this resin or silica support as shown in Figure 1C. To further support this point, attached to this response is literature from the company that supplied the fullerenes in the examples of Stalling et al. As can be seen, Fullerene C₆₀ and Fullerene C₇₀ have a size of 7 - 9 Å diameter, which is significantly smaller than 1 micron. This would make sense because the fullerene would have to be significantly smaller than the size of the resin or silica support to which it is being ultimately attached to. Stalling et al. does not teach carbonaceous particles

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having a size of 1 to 500 microns. Accordingly, Stalling et al. is quite different from the claimed invention and this has been further emphasized with the amendments to claims 1, 5, and 6 for the benefit of the Examiner.

Also, the abstract of Stalling et al. only states that the invention relates to fullerenes covalently bonded to a polymer particle or a siliceous support particle, and col. 4, lines 58 - 66 of Stalling et al. only describes reactive groups such as $-\text{CH}_2\text{X}$, $-\text{OH}$, $-\text{NH}_2$ and $-\text{COOH}$ being bonded onto the fullerene to facilitate the attachment of the fullerene to a polymer particle. Column 5, lines 34-38 describes the polymers and the siliceous supports as support particles that are known for use as adsorbents. The applicants submit that these particles are not or do not contain the claimed organic groups.

Regarding Figure 10B of Stalling et al., it merely shows a linkage between a fullerene and a polymer particle, but this linkage and the polymer particle are not organic groups as claimed. Contrary to what is alleged by the Examiner, an "aromatic- $(\text{C}_n\text{H}_{n+1})$ " group is not a group that is defined in the claims, nor is such a group disclosed in Stalling et al. The Examiner seems to intend to refer to the " $-\text{Ar}-(\text{C}_n\text{H}_{2n+1})_x$ " group, which is included in claim 19. Stalling et al. does not disclose any such group and, in particular, this group is not the linkage that is shown in Fig. 10B of Stalling et al. The formula " $-\text{Ar}-(\text{C}_n\text{H}_{2n+1})_x$ " requires that the aromatic portion of the defined group be attached to the carbonaceous material (since, as noted at page 22, lines 23-25, hyphens on one or more ends of a formula indicate the attachment to the carbon product or to another group). Moreover, according to the formula, none of the one or more aliphatic groups that are attached to the aromatic group connect to any other group, but rather, each ends in a methyl group. The linkage shown in Fig. 10B of Stalling et al., on the other hand is a C_8H_{16} chain

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joined at one end to an oxygen atom bonded to a fullerene and joined at the other end to an NH group of a polystyrene-NH₂ polymer particle. Stalling et al. contains no teaching or suggestion of a carbonaceous material having an aromatic group attached to the carbonaceous material and one or more non-linking aliphatic groups (that is, groups that end in CH₃) attached to the aromatic group, as required by claim 19. Moreover, Stalling et al. contains no teaching or suggestion of a carbonaceous material with an attached polyethylene glycol or methoxy-terminated polyethylene glycol or derivatized resins thereof as required by claim 21, which the Examiner appears to suggest. Contrary to what is alleged by the Examiner, this feature is not disclosed at col. 9, lines 10 - 21 of Stalling et al. This passage of Stalling et al. refers to glycol dimethacrylate, triethyleneglycol dimethacrylate and tetraethyleneglycol dimethacrylate as crosslinking agents that are combined with monomers in the formation of a core-shell polymer particle, which is one of the support particles mentioned in the reference. This particular passage of Stalling et al. has nothing to do with fullerenes, but rather relates to the formation of a specific type of particle to which a fullerene may be attached. Stalling et al. contains absolutely no description of a carbonaceous material that has an attached polyethylene glycol or methoxy-terminated polyethylene glycol or derivatized resins thereof. Moreover, since Stalling et al. does not teach or suggest any organic groups attached to a carbonaceous material, Stalling et al. would not teach or suggest any chromatography column or separation device as required by independent claims 1, 5 and 6, and therefore their dependent claims 2-4, 7, and 9. Therefore, this rejection should be withdrawn.

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Rejection of claim 17 under 35 U.S.C. §103(a) over Stalling et al. in view of Kusano et al.

At page 3 of the Office Action, the Examiner rejects claim 17 under 35 U.S.C. §103(a) over Stalling et al. in view of Kusano et al. (EP 0 300 448). The Examiner acknowledges that Stalling et al. does not disclose that the organic molecule that is attached to the carbonaceous material is an amino type molecule as claimed. The Examiner alleges that Kusano et al. shows the use of the claimed amino type molecule as a separation medium. The Examiner takes the position that it would have been obvious to modify Stalling et al. with the teachings of Kusano et al. on the alleged grounds that Kusano et al. teaches the use of amino type molecules in a separation medium for chromatography. For the following reasons, this rejection is respectfully traversed.

As discussed above, Stalling et al. attaches a very small diameter fullerene onto a conventional resin or silica support. This is clearly different from the claimed invention, as described above in the rejection of claims 1-7 and 9 and these differences and comments apply equally here and are incorporated in their entirety by reference herein.

Stalling et al. only describes reactive groups as being bonded onto fullerene to facilitate the attachment of the fullerene to an inorganic polymer or siliceous particle or the attachment of fullerenes to each other. As discussed, for example, at col. 4, line 50 to col. 5, line 15, of Stalling et al., the chromatographic material of Stalling et al. is a lattice structure of joined fullerenes and polymer or siliceous particles. Therefore, Stalling et al. only describes groups such as -CH₂X, -OH, -NH₂ and -COOH that are capable of facilitating the formation of a lattice structure and does not teach or suggest any other use for reactive groups attached to the fullerenes. In particular, Stalling et al. does not teach or suggest any modification of fullerenes with organic groups that

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affect the selectivity of a chromatographic material and there is no indication that it would even be possible to make a stable modification of this type to a fullerene. Kusano et al. does not overcome the deficiencies of Stalling et al. Kusano et al. describes the use of a coating of an optically active amino acid derivative on a substrate to provide a separation medium for separating racemic mixtures.

Also, if Stalling et al. was somehow combinable with Kusano et al., one skilled in the art would remove the fullerene and attach an amino acid onto the conventional resin or silica substrate of Stalling et al. This would clearly be different from the claimed invention since the claimed invention is using the carbonaceous material as the "substrate" to attach organic groups onto. There is no teaching or suggestion in Stalling et al. or Kusano et al., either singly or combined, that the amino acid derivatives of Kusano et al. would be capable of performing the function of facilitating the attachment of fullerenes to polymer particles to form a lattice structure, or even that the amino acid derivatives of Kusano et al. could be attached to fullerenes at all. Kusano et al. does not teach any attachment of its amino acid derivatives to anything, but rather only describes coating the amino acid derivatives onto a substrate. Accordingly, Stalling et al. and Kusano et al., either singly or combined, do not teach or suggest a separation device comprising a mobile phase and a stationary phase, wherein the stationary phase comprises carbonaceous material having attached at least one amino acid or derivatized amino acid, cyclodextrin, immobilized protein, polypeptides, or combinations thereof, as required by claim 17. Therefore, this rejection should be withdrawn.

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Rejection of claims 8, 10, 16 and 18-49 under 35 U.S.C. §103(a) over Stalling et al. in view of Boes et al.

At page 3 of the Office Action, the Examiner rejects claims 8, 10, 16 and 18-49 under 35 U.S.C. §103(a) over Stalling et al. in view of Boes et al. (the Examiner seems to intend to refer to the previously cited U.S. Patent No. 5,807,494). The Examiner acknowledges that Stalling et al. does not disclose the specific types of chromatography nor the other types of molecules that can be attached to carbonaceous material, as claimed. The Examiner alleges that Boes et al. shows the use of a variety of organic groups that are attached to a carbonaceous material, which includes the claimed organic groups. The Examiner takes the position that it would have been obvious to modify Stalling et al. with the teachings of Boes et al. on the alleged grounds that Boes et al. teaches the use of other types of organic molecules that can be attached to a carbonaceous material. For the following reasons, this rejection is respectfully traversed.

As discussed above, Stalling et al. only describes reactive groups as being bonded onto fullerene to facilitate the attachment of the fullerene to an inorganic polymer or siliceous particle or the attachment of fullerenes to each other. Stalling et al. does not teach or suggest carbonaceous particles having a size of about 1 micron to 500 microns.

As discussed, for example, at col. 4, line 50 to col. 5, line 15, of Stalling et al., the chromatographic material of Stalling et al. is a lattice structure of joined fullerenes and polymer or siliceous particles. Therefore, Stalling et al. only describes groups such as $-\text{CH}_2\text{X}$, $-\text{OH}$, $-\text{NH}_2$ and $-\text{COOH}$ that are capable of facilitating the formation of a lattice structure. Boes et al., on the other hand, describes carbon black products that have attached organic groups that provide the advantage of increased water dispersibility (see, for example, col. 5, lines 23 - 37 of Boes et al.).

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Clearly, this objective of providing increased water dispersibility is directly at odds to the objective in Stalling et al. of joining particles together into a lattice. There is no teaching or suggestion in Boes et al. of using organic groups to attach carbon black particles to anything else. Therefore, a person skilled in the art would not be motivated to modify Stalling et al. with the teachings of Boes et al. Moreover, since Stalling et al. does not teach or suggest any other use for reactive groups attached to the fullerenes except for providing the fixation of fullerenes and polymer or siliceous particles and since Boes et al. contains no disclosure relevant to chromatography at all, the advantages described in the present application of affecting the adsorption properties and the selectivity of a chromatographic material by attaching organic groups is not found in either reference, taken singly or combined. One skilled in the art would have no reason to look to Boes et al. The carbon materials are different and the uses are different. Accordingly, Stalling et al. and Boes et al., either singly or combined, do not teach or suggest a separation device comprising a mobile phase and a stationary phase, wherein the stationary phase comprises carbonaceous material having attached thereto the specific groups required by claims 8, 10, 16 and 18-49. Therefore, this rejection should be withdrawn.

CONCLUSION

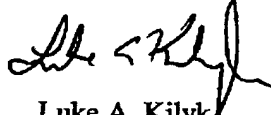
In view of the foregoing remarks, Applicants respectfully request the reconsideration of this application and the timely allowance of the pending claims.

If there are any fees due in connection with the filing of this response, please charge the fees to Deposit Account No. 03-0060. If a fee is required for an extension of time under 37 C.F.R. § 1.136 not accounted for above, such extension is requested and should also be charged

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to said Deposit Account.

Respectfully submitted,

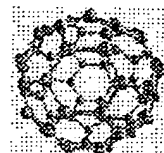


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Atty. Docket No. 96074CIP (3600-011-02)
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Attachment: Literature from MER Corporation regarding MER Fullerene Products
(2 pages)



MER Fullerene Products



Item: Fullerene Soot

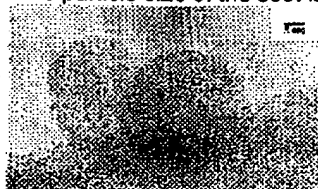
Catalog# MRST

Description: As-produced carbon soot prepared by the Kraetschmer-Huffman arc process. MER fullerene soot is guaranteed to yield over 7 wt% fullerenes when extracted with toluene. Typical composition of the extract is 75% C₆₀, 22% C₇₀, 3% higher-order fullerenes. The particle size of the soot is 0.02 to 10 microns. Powder density is about 0.05 grams/cc.

Prices for As-produced Fullerene Soot, Catalog# MRST.

Up to 100 grams \$3.00 per gram

Over 100 grams \$2.00 per gram



Item: Refined Mixed Fullerenes

Catalog# MRMF

Description: Fullerene extracted from arc-produced carbon soot. The fullerene mixture (also known as "fullerite") is a dark-brown amorphous powder that is soluble in toluene, benzene, carbon disulfide and other fullerene-friendly solvents. Fullerene composition is approximately 75% C₆₀, 22% C₇₀ and 3% higher-order fullerenes (C₇₆, C₇₈, C₈₄ and others). Powder density is about 0.8 g/cc.

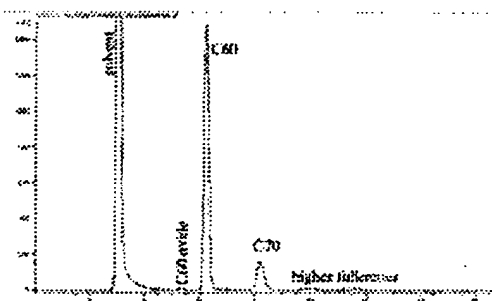
Prices

1-10 grams \$20.00 per gram

11 to 100 grams \$18.00 per gram

MRMF

Over 100 grams \$15.00 per gram



Typical HPLC Chromatogram of

Item: Fullerene C₆₀, 99+%

Catalog# MR6LP

Description: Over 99% pure C₆₀ produced by chromatography. The product is a dark brown powder with powder density of about 0.8 g/cc. Impurities include C₇₀ and C₆₀ oxides. The material may also contain up to 0.2% adsorbed solvent.

Prices

1-10 grams \$40.00 per gram

11-50 grams \$30.00 per gram

51-100 grams \$25.00 per gram

over 100 grams \$20.00 per gram

7 Å diameter



C₆₀

Item: Fullerene C₆₀, 99.9%

Catalog# MR6HP

Description: 99.9% or higher C₆₀ produced by chromatography and sublimed to remove traces of solvent and other contaminants. The product is a black crystalline powder with powder density of about 0.8 g/cc. Impurities are traces of C₇₀ and C₆₀ oxide.

Prices

1-5 grams \$75.00 per gram

6-25 grams \$65.00 per gram

26-100 grams \$60.00 per gram

over 100 grams \$50.00 per gram



Optical Micrograph of MR6HP (100X)



MER Fullerene Products

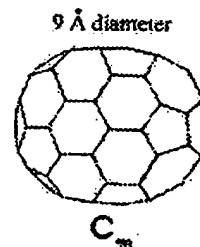
Item: 95+% C₇₀

Catalog# MR7LP

Description: C₇₀ produced in the arc, then purified to over 95% by chromatography. The material is a dark brown powder with powder density of about 0.8 g/cc. Impurities include C₆₀, higher order fullerenes and fullerene oxides. The product may contain up to 0.2% absorbed solvent.

Prices

1 gram	\$280
2-5 grams	\$270.00 per gram
6-25 grams	\$250.00 per gram
over 25 grams	ask



Item: 99+% C₇₀

Catalog# MR7HP

Description: 99% or higher purity C₇₀ produced in the arc, purified by chromatography, then sublimed to remove traces of solvent and other contaminants. The product is a black crystalline powder with powder density of about 0.8 g/cc. Impurities are traces of higher fullerenes and C₇₀ oxide.

Prices:

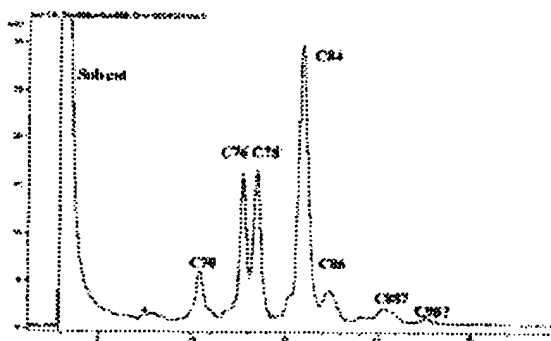
1 gram	\$400.00
2-5 grams	\$350.00 per gram
6-25 grams	\$325.00 per gram
over 25 grams	ask

Item: Higher-Order Fullerene Mixture

Catalog# MRHF

Description: Mixture of higher-order fullerenes produced by chromatography. Typical composition is around 20% C₇₆, 20% C₇₈, 40% C₈₄, with other higher-order fullerenes. A HPLC chromatogram is supplied with the material to indicate approximate distribution of fullerenes. Limited quantities are available.

Price: \$3.00 per mg



Typical HPLC Chromatogram of MRHF

Please fax purchase orders to MER Corporation Nanotubes at ++(520) 574-1983.

Payment in US\$ is due 30 days after receipt of the invoice. Payment accepted by check, money order, EFT or major credit card. Call or email for payment instructions.

Please email, call or write if you need a formal quotation, delivery estimate or if you have questions.

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